

REMARKS

1. Pursuant to the above-noted Office Action, Claim 11 was rejected under 35 U.S.C. 112, second paragraph. Claims 1 and 14 - 18 were rejected under 35 U.S.C. §102(b) in view of Grube (European Patent Publication No. 0 475 022 A1) ("Grube"). Claims 1-4, 21, 22, 25, 26, and 28 were rejected under 35 U.S.C. §102(e) in view of Grigg (U.S. Patent Publication No. 2001/0038144 A1) ("Grigg"). Claims 19 and 20 were rejected under 35 U.S.C. §103(a) given Grube in view of Spigarelli et al. (U.S. Patent No. 5,251,266) ("Spigarelli"). Claims 1 and 4 -13 were rejected under 35 U.S.C. §103(a) given Capote et al. (U.S. Patent No. 6,355,571) ("Capote") in view of Lin (U.S. Patent No. 6,335,571) ("Lin"). Claims 23, 24, and 26 were rejected under 35 U.S.C. §103(a) given Grigg in view of Zhou et al. (U.S. Patent No. 5,985,456) ("Zhou"). These rejections are respectfully traversed.

2. Pursuant to the above-noted Office Action, Claim 11 was rejected under 35 U.S.C. 112, second paragraph. In particular, the Examiner noted that the initial appearance of the expression "drying" was without antecedent basis. As correctly supposed by the Examiner, this word should have read as "processing" instead. The applicant apologizes for this error and has provided the appropriate correction in the submitted amendment. The applicant respectfully submits that claim 11 is now in suitable condition to support continued examination and a finding of allowability.

3. Claims 1 and 14 -18 were rejected under 35 U.S.C. §102(b) in view of Grube. The Examiner contends that Grube teaches providing an interposer, attaching a semiconductor die to the interposer, and disposing an underfill material on an opposing side of the interposer prior to placing the interposer on a printed wiring board. Prior to discussing the merits of these contentions, the applicant believes it will be helpful to first briefly describe and characterize Grube in more detail.

Grube teaches that an interposer can be positioned between an integrated circuit (a "chip" in the vernacular of the Grube reference) and a substrate. This interposer is comprised of insulating material. In addition, this interposer has vias formed fully therethrough to permit access to the conductive contact patterns on the integrated circuit. Grube then teaches that these vias are filled with a conductive

attachment material (such as a paste of material that includes finely ground metal particles). The vias of the interposer are then aligned with the conductive contact pattern on the substrate and the combined assembly is pressed together and heated. So configured, the conductive fill material in the vias of the interposer serves to electrically couple the conductive surfaces on the substrate to the conductive contact patterns on the integrated circuit itself.

No other conductive coupling occurs between the substrate and the integrated circuit aside from these conductive pathways through the conductive material in the interposer vias. It can also be seen that this conductive material, as applied to the interposer, does not fulfill an "underfill" function; instead, this material serves an "innerfill" function as it fills the vias that are disposed through and within the interposer. Indeed, a study of Grube clearly reveals that Grube's proposed interposer comes into full contact with the substrate, leaving no room for an underfill as such.

The present invention as claimed differs from Grube in a variety of ways. For example, the claims all require an "underfill" material while Grube plainly does not disclose or suggest any such concept (in fact, Grube teaches the opposite - he teaches that an interposer itself sans any fill material should directly contact the substrate without any intervening space whatsoever).

Grube also teaches only the use of an electrically conductive fill material. The applicant, however, discloses embodiments where multiple discrete conductors are all embedded within the same body of underfill material - using a conductive fill material as per the teachings of Grube would render the resultant assembly ineffective by short circuiting all of these discrete conductors with one another. To more clearly reflect this distinction, the applicant has amended the claims to clearly denote that the underfill material comprises a "non-conductive" material.

The applicant therefore respectfully submits that claims 1 and 14 -18 are clearly distinguished from Grube and are not anticipated by this reference.

4. Claims 1-4, 21, 22, 25, 26, and 28 were rejected under 35 U.S.C. §102(e) in view of Grigg. The Examiner contends that Grigg teaches providing an interposer having a semiconductor die attached thereto and placing an underfill material on an opposing side of the interposer prior to placing the interposer/die assembly on a

substrate. Prior to discussing the merits of these contentions, the applicant believes it will be helpful to first briefly describe and characterize Grigg in more detail.

Grigg seeks to provide a mechanism whereby portions of the die/interposer assembly can be encapsulated to thereby protect the latter from the local environment. More particularly, Grigg is not concerned with providing an underfill material between the interposer and a substrate; in particular, Grigg is not interested in "filling" the space under the interposer when the latter is disposed on the substrate. In fact, Grigg appears to teach that such a filling is an undesirable condition and should be avoided. Instead, Grigg appears to advise that the encapsulating material should be of relatively low profile with respect to, for example, the conductive structures that extend outwardly of the interposer.

To meet this need, Grigg teaches that structures are formed on the interposer to act as boundaries or, in effect, a dam to restrain and confine the flow of the encapsulating material when introduced onto the surface of the interposer. The height of these dams is well below the outer dimensions of the conductive structures of the interposer to ensure that the encapsulating material does not extend too far in a vertical direction. These dams ensure that the encapsulating material cannot become an "underfill" material because the space "under" the interposer when disposed on the substrate cannot be "filled" due to this defining structure.

These claims are therefore readily distinguished from Grigg as the claims all require an "underfill" material whereas Grigg makes no such teaching or suggestion (in fact, Grigg appears to lead one away from underfilling). Grigg teaches only the provision of an encapsulating material that avoids actually filling the space under the interposer.

5. Claims 19 and 20 were rejected under 35 U.S.C. §103(a) given Grube in view of Spigarelli. Both of these claims are ultimately dependent upon claim 1, which claim has been shown allowable above with respect to Grube. Furthermore, these claims do not introduce their added content in an abstract setting. Rather, these claims introduce new content within the context of the recitations of the claims from which they depend. The applicant respectfully submits that these claims introduce additional incremental patentable subject matter when viewed in light of such context.

6. Claims 1 and 4 -13 were rejected under 35 U.S.C. §103(a) given Capote in view of Lin. The Examiner contends that Capote teaches providing a semiconductor die and, prior to placing this die on a substrate, placing an underfill material thereon. The Examiner concedes that Capote fails to disclose use of an interposer, but proposes that Lin's disclosed use of an interposer can be combined with Capote to meet the recitations of the claims. Prior to discussing the merits of these contentions, the applicant believes it will be helpful to first briefly describe and characterize Grigg in more detail.

Capote teaches the use of two underfill materials to bridge a gap between a die and a substrate. Capote particularly suggests that a first underfill material be applied to the die and a second, different underfill material be applied to the substrate prior to combining the two pieces into a common assembly. Consequently, Capote does not teach providing a complete "underfilling" on either the die or the substrate alone - it is the final combination that provides sufficient material to actually "fill" the available space.

More importantly, however, Capote does not teach the use of an interposer. The Examiner suggests that use of an interposer can be introduced into Capote from another reference. Making such a combination, however, would require the person of average skill in the art to ignore the teachings of the primary reference itself. In particular, Capote himself notes the prior practice of using an interposer in his description:

" In the past, the problem of solder joint fatigue life in flip-chip/substrate interconnects was addressed by several methods. A typical approach, which is described in U.S. Pat. No. 5,801,449, involves positioning an interposer made of flexible circuitry between the chip and the solder joints. The flex. circuit undergoes expansion and contraction without distorting the solder joints despite the presence of the air gap around the solder joints."

Capote then notes the prior practice of using an underfill material between a die and a substrate, and distinguishes the latter from the former as follows:

" Unlike the previous interposer methods, there cannot be an air gap or separation between the underfill 104 and the chip 100 or the substrate 101."

Capote, then, is clearly shown to both note the use of interposers and to teach the reader that such interposers are to be used *without* an underfill material. Furthermore, while Capote offers numerous criticisms of the prior art underfill processes, he suggests no issues whatsoever with interposers. Instead, interposers are essentially set forth in Capote as being a satisfactory stand-alone solution. In short, Capote teaches that interposers and underfill materials are different, alternative approaches to reliably securing a die to a substrate, and that his teachings regarding the use of a two-layer underfill material are solely directed to the latter and *not* to the former.

Consequently, the applicant respectfully submits that one skilled in the art, upon reviewing Capote as a whole, would not be led to move in a fashion contrary to the explicit teachings of Capote and nevertheless utilize an interposer when also using Capote's two-layer underfill process.

For all of these reasons, the applicant respectfully submits that these references do not render these claims obvious.

7. Claims 23, 24, and 26 were rejected under 35 U.S.C. §103(a) given Grigg in view of Zhou. The Grigg reference has been addressed above and those comments are relevant here as well. For the sake of brevity those comments will not be repeated here again. Given the shortcomings of Grigg, the applicant respectfully submits that a combination of Grigg with Zhou (presuming only for the sake of this discussion that such a combination could indeed be considered obvious) nevertheless fails to meet the recitations of these claims.

8. There being no other objections to or rejections of the claims, the applicant respectfully submits that claims 1 through 28 may be passed to allowance.

Respectfully submitted,

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